the facts. Besides, the truth in these particulars would aid in the solution of a host of other problems.

There is, then, ample reason for trying to measure the temperature and determine the composition of the outer and as yet unexplored portions of our atmosphere.

A possible general scheme, the details of which might vary greatly, for obtaining these data is as follows:

1. The height will be attained by means of a rocket of the type, say, now being developed by Professor Goddard of Clark University.

2. A highly exhausted, thin-walled, and hermetically sealed tube is carried on or in the head of the rocket.

3. This tube is surrounded by water and a little ice, and the containing vessel more or less thermally insulated from the adjacent air—suggested by a constant temperature device used with balloon pyrheliometers by Abbot, Fowle, and Aldrich.[6]

4. At about the top of the flight the drawn-out tip of the exhausted tube is broken off near its end by a device actuated by the exhaustion of the rocket propellant, or otherwise, as may seem best.

5. As soon as the tube has filled—that is, in a second or two after it was opened, and actuated by the equilibrium between internal and external pressure thus obtained, or otherwise—the tube is again hermetically sealed. This can be done by the short-circuiting of a minute electric cell through a fine platinum wire wound around the drawn-out neck.

The last two suggestions, (4) and (5), are taken from the method successfully used by Teisserenc de Bort in getting samples of air with sounding balloons.

6. At the time the tube is being filled, a flash light of the kind (there are such) that will operate in air of any pressure, however low, is fired. This presupposes that the air catch is to be made on cloudless nights during the dark of the moon.

7. At two or more suitable stations the flash is photographed amidst the stars with appropriate cameras. This gives, very approximately, the level at which the sample of air was obtained, and is the same scheme as that used by Störmer and others for measuring the heights of auroras.

If all has gone according to plan, and the tube, let down by parachute, or otherwise protected, has been found, we now have a sample of the air taken in at a known height and known temperature, 0° C. (as secured by the ice and water-jacketing of the sampling tube), whatever the surrounding temperature, but unknown pressure. Obviously, however, this pressure, the pressure of the entrapped gas when at 0° C., can be measured at leisure in the laboratory. Furthermore, the constituents of the sample of air, and their relative amounts, are matters of gas analysis of any desired refinement.

A series of such samplings, made at height intervals of 5 to 10 kilometers, would give us the approximate composition of the atmosphere and its pressure at each of various known heights. From these data in turn the corresponding temperatures could be closely computed, since only one distribution of temperature could give, with the known gases, the particular pressures thus found, assuming, of course, that, as shown by Atkinson [7] the pressure of the atmosphere at all levels is essentially of gravitational origin and not appreciably affected by electrification.

Evidently, the observations suggested above would require skill and ingenuity, but they clearly are possible and the facts to be learned highly desirable.

PAPERS READ AT THE PORTLAND, OREG., MEETING OF THE AMERICAN METEOROLOGICAL SOCIETY, JUNE 18, 1925

(For other papers presented at the same meeting, see the Bulletin of the American Meteorological Society)

WIDE AREA FORECASTING OF STREAMFLOW ON THE COLUMBIA AND COLORADO

By J. E. CHURCH, Director

[Mount Rose Observatory, Reno, Nevada]

West of the Great Continental Divide the United States lives and has its being in its streams.

Three watersheds or series of river systems, arranged in combination like a gothic A, serve this vast region. Dividing between them 1,600 miles of the western apex of the Continental Divide, the Columbia and Colorado flow westward through tributary regions of 237,000 and 225,000 square miles, respectively, to the sea. Connecting them and forming the crossbar of the A, is the Sierra Nevada system furrowed by streams of lesser length but whose combined output exceeds by nearly twice the output of the Colorado.

Contrary to expectation, the relative flow from these three watersheds is Colorado 1, Sierra Nevada 2, Columbia 9, or an annual run-off from the Colorado of 17,500,000 acre-feet, from the Sierra Nevada approximately 32,500,000 acre-feet, and from the Columbia 151,700,000 acre-feet.

Upon the impounding and distribution of these life streams depend the growth and prosperity of the Pacific coast. As a basic factor in their control and maximum use, the Mount Rose Observatory with cooperation from the U. S. Weather Bureau has devoted its energies during the past decade and a half to investigating the possibility of forecasting the seasonal run-off from the streams in the Sierra Nevada and ultimately from the Columbia and Colorado as well.

The possibility of wide-area snow surveying and close forecasting of the subsequent run-off has now been so thoroughly established in the central Sierra Nevada that the city of Los Angeles has adopted the method for its aqueduct in the Owens Basin and for its power projects elsewhere in the Southern Sierra. Through this action of Los Angeles opportunity will soon be afforded to test the system under extreme conditions of altitude and run-off.

Detailed investigation of the Columbia and Colorado watersheds has revealed the fact that despite their immense areas satisfactory snow surveys and forecasts can be established for each at no greater difficulty and expense than for the joint streams of the central Sierra Nevada. The only new element involved is the higher relative precipitation in summer on the Continental Divide which may affect the run-off beyond the indications of the snow survey and early rains.

The simplicity of the problem is based upon the following peculiarities:

Despite the apparent vast area of their watersheds, these streams are fed in large part by three main feeders that supply from 77 to to 87.1 per cent of their total annual flow. Furthermore, the flow in the main stream, based, however, upon short records only, varies less than 11 per cent from the combined flow of the feeders and the extreme variation between even one feeder and the main stream, over a long term of years, has not exceeded 25 per cent. Finally, from 61 to 64 per cent of the entire annual flow occurs during the four months of April-July, due to the fact that the major supply comes from winter snows, which do not begin to melt until late in March. Therefore, a few snow surveys well placed on these main feeders should indicate the amount of water available for the season's crops and industrial needs.

Furthermore, they will indicate the danger of spring floods from the upper streams and in case the reservoirs are maintained at maximum level, as must be the case when the water is put to maximum use, the reservoirs can be eased down to prepare storage for flood waters rather than permit the streams to flow full volume over the crests and menace the lands along the lower stream.

Fortunately, the winter floods that traverse western Oregon and Washington come mainly from the Cascades and find ready escape in the huge channel of the Columbia, which in the winter flows only at minimum stage because of the dormant snows on its main watershed.

[6] Smithsonian Miscellaneous Collections, Vol. 65, No. 4, 1915

[7] Proc. Roy. Soc., A 106, 429, 1924.

The future promise of the Columbia Basin, even now called the Inland Empire, when its waters are assigned their full duty, is best expressed in terms of the run-off of its three tributaries: Upper Columbia or Kootenay, 53,000,000 acre-feet; Pend Oreille, already center of a wide project, 19,000,000 acre-feet; and Snake, 45,000,000 acre-feet. But the presence of volcanic soil makes this promise larger, for even at low stages the net recovery on the Snake, after practically the entire flow has been used four times, is still 39 per cent.

The problem of building up the lesser but warmer Colorado Basin is even now at the door, and the equitable division of the water before it passes down the stream will underlie the development of seven States. The Green will furnish 5,700,000 acre-feet, the Grand 7,500,000 acre-feet, and the San Juan 3,100,000 acre-feet. The tiny Gila will furnish only 1,000,000 acre-feet, and of this only 159,000 acre-feet flows in April–July, when the need is greatest.

However, from this and other small additions, must be deducted 1,800,000 acre-feet, much of which apparently sinks in the delta above Yuma and seeps slowly to the Gulf. The problem of reclaiming this underground flow by artificial dikes will depend upon the relative value of the completed work.

THE CLIMATE OF BRITISH COLUMBIA

By F. NAPIER DENISON

[Meteorological Office, Victoria, B. C.]

Owing to the mountainous character of portions of this Province, its climate varies greatly according to local physical conditions.

The heaviest precipitation occurs on the western slopes of the Coast Ranges, the lightest between the coast and Selkirks, and increases eastward to the Rockies. The heaviest precipitation amounts to 120 inches on the west coast of Vancouver Island, about 180 inches on the high levels to the eastward of the city of Vancouver, while the wettest area on our coast is in the vicinity of Swanson Bay, near Princess Royal Island. Owing to the less mountainous character of the Queen Charlotte Islands as compared with Vancouver Island, the precipitation there is lighter, amounting to about 100 inches on the west coast and 50 inches on the eastern side.

Between the Coast and the Selkirk Ranges much of the southern area is termed the "dry belt," while extending northward between these ranges, which decrease in altitude, the Pacific Ocean LOWS spread inland and sufficient precipitation occurs for general vegetation. Further eastward climatic conditions become decidedly local throughout the Selkirk and Rocky Mountains.

The following table gives the average annual precipitation for certain typical stations, extending from the west coast to the Rockies across both southern and northern British Columbia. The elevations are also given.

TABLE 1.—*Average precipitation and elevation of certain British Columbia stations*

Station	Elevation	Precipitation
Southern group	*Feet*	*Inches*
Clayoquot	27	119.13
Nanaimo	125	37.46
Victoria	230	27.65
Vancouver	136	58.76
Kamloops	1,262	10.08
Penticton	1,200	11.21
Nelson	2,230	26.86
Invermere	2,650	11.47
Northern group		
Masset Q. C. I.	10	53.99
Prince Rupert	170	101.74
Prince George	1,867	18.11
Fort St. James	2,280	15.75
Barkerville	4,180	36.63
Glacier	4,072	60.24

Even at the low level of 27 feet on the western coast of Vancouver Island the precipitation is 119 inches, while in crossing the island to Nanaimo the yearly total drops to 37 inches, and at the southeastern part of the island about Victoria it is only 27.65 inches. The influence of the mainland coast mountains is clearly seen by the marked rise to 58 inches at Vancouver, while Kamloops and Penticton in the "dry belt," where irrigation has made a wonderful fruit-growing district, only 10 and 11 inches, respectively, is the annual amount. At the higher elevation at Nelson in Kootenai the precipitation rises again to 27 inches.

Crossing the northern part of the Province, Masset on the east coast of the Queen Charlotte Islands has 54 inches and Prince Rupert on the north coast mainland 102 inches, while east of the coast mountains the northern interior has from 6 to 8 inches more precipitation than in the southern interior, already mentioned. Barkerville in Caribou and Glacier in the Rockies are given to show the increased precipitation at stations over 4,000 feet.

In connection with heavy precipitation in this Province, it appears that at Henderson Lake on the west coast of Vancouver Island, where we now have a station, the annual precipitation was 228 inches in 1923, with 79 inches in December, and in 1924 the yearly total was 281 inches. It is probable that owing to peculiar local conditions this station may prove to be the wettest spot not only in this Province but on the North Pacific coast.

Mean temperature and bright sunshine.—In the following table the mean temperature is shown for the coldest and warmest months of the year, together with the annual amount of bright sunshine, for certain typical stations, including Edmonton, Alberta, for purposes of comparison.

TABLE 2.—*Mean temperature and bright sunshine*

Station	January	July	Range	Annual hours sunshine
	°F.	°F.	°F.	
Victoria	39	60	21	2,163
Nanaimo	36	63	27	1,898
Prince Rupert	32	57	25	1,214
Vancouver	36	63	27	1,829
Kamloops	22	69	47	2,118
Vernon	21	66	45	2,089
Summerland	22	68	46	2,034
Nelson	25	66	41	1,895
Grand Forks	20	69	49	----------
Invermere	13	63	50	1,994
Cranbrook	17	62	45	----------
Edmonton, Alberta	6	61	55	2,137

In connection with these figures one is struck by the remarkably small seasonal range of temperature and large amount of sunshine as shown at Victoria. These conditions are due to the open nature of the land about there, and the moderating influence of the ever-changing tidal waters which almost surround that portion of Vancouver Island affect the temperature.

The seasonal range of temperature increases eastward to the dry belt and where the annual amount of bright sunshine is naturally high, yet still less than at Victoria.

The temperature extremes are greatest in Kootenai in the list of stations. A comparison shows that the southeastern portion of Vancouver Island records more bright sunshine than even parts of "Sunny Alberta."

THE CLIMATE OF OREGON DURING THE PLEISTOCENE PERIOD

By EDWIN T. HODGE, Professor of Geology

[University of Oregon]

(Author's Abstract)

Previous studies of the Pleistocene of British Columbia, Washington, and Oregon have brought out two statements regarding the climate of that time. They state that "the temperature gradually grew colder and finally culminated in the development of glaciers" and that a great sound occupying the Willamette Valley was developed at the close of the Pleistocene. This latter statement, if true, would likewise indicate a colder climate. The presence of a large body of water, in contrast to an equivalent land surface, reflects most of the light energy received, its latent heat is high, and evaporation from whatever cause results in cooling.

As a result of studies extended over the past eight years I have arrived at conclusions which materially differ from those hitherto published regarding geological events of the Pleistocene period of Oregon and Washington. These conclusions will be published elsewhere. If my theory regarding the events of the Pleistocene are correct, then the following deductions may be made regarding Pleistocene climate:

The period was introduced by the Pliocene uplift. This uplift continued into the Admiralty epoch, which brought the Coast Range and Cascades to an elevation whereby they intercepted a large part of the moist winds coming from the Pacific Ocean. The moist winds during most of the Pliocene were able to pass over the low mountains and fed large lakes in eastern Oregon, Washington, and California. The increment in the precipitation, due to the elevation along this coast, in the less-favored localities amounts to